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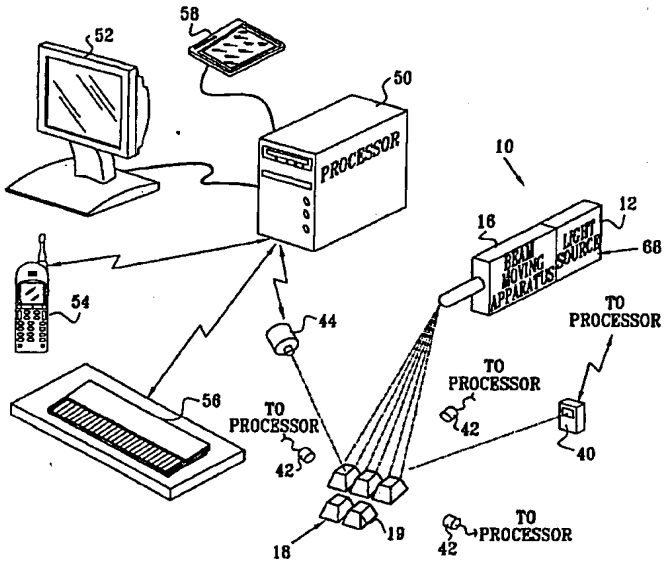
(54) Title: VIRTUAL DATA ENTRY DEVICE AND METHOD FOR INPUT OF ALPHANUMERIC AND OTHER DATA



(57) Abstract: A data input device (10) including an optically generated image of a data input device, the image including at least one input zone (19) actuable by an action performed thereon by a user, a sensor (42-44) operative to sense the action performed on the at least one input zone, and to generate signals in response to the action, and a processor (50) in communication with the sensor operative to process the signals for performing an operation associated with the at least one input zone (19).

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VIRTUAL DATA ENTRY DEVICE AND METHOD FOR INPUT OF ALPHANUMERIC AND OTHER DATA

FIELD OF THE INVENTION

The present invention relates to apparatus and methods for inputting information into a computer.

BACKGROUND OF THE INVENTION

The following U.S. Patents are believed to represent the current state of the art:

6,100,538	6,107,994	5,914,709	5,977,867	6,005,556	6,031,519
5,863,113	5,748,183	5,748,512	5,767,842	4,553,842	4,688,933
4,782,328	5,502,514	5,633,691	5,831,601	5,786,810	5,909,210
5,880,712	5,736,976	5,818,361	5,867,146	5,785,439	5,577,848
5,793,358	5,595,449	5,581,484	6,104,384	5,748,512	5,821,922
5,864,334	6,094,196	5,936,615	5,835,094	6,097,375	5,933,132
5,986,261	5,705,878	5,677,978			

The following patent documents are believed to be most relevant to the present invention: U.S. Patents 5,734,375; 5,736,976; 5,767,842; 6,031,519; 6,043,805 and Published PCT Patent Application WO 00/21024.

SUMMARY OF THE INVENTION

The present invention seeks to provide improved apparatus and methodologies for inputting at least alpha-numeric information into a computer.

The present invention seeks to provide a novel and improved data input device. In many embodiments of the present invention, there is no physical input device in the usual sense of the word, rather an optical image of a data input device is generated. A light beam emanating from a light source (e.g., laser source) is preferably moved at high speed by means of a mirror array or scanner, for example, to form a two-dimensional or three-dimensional image of an input device, such as a keyboard with all of the keys, in which case the user presses "virtual" keys of a "virtual" optically generated keyboard. Another example of an optically generated input device is a

laser source and using color and wavelength splitters. Differently polarized light beams can also be used. The keyboard of the present invention can not only be used as the sole data input device, but can also be integrated with other conventional or non-conventional data input devices.

There is thus provided in accordance with a preferred embodiment of the present invention a data input device including an optically generated image of a data input device, the image including at least one input zone actuable by an action performed thereon by a user, a sensor operative to sense the action performed on the at least one input zone, and to generate signals in response to the action, and a processor in communication with the sensor operative to process the signals for performing an operation associated with the at least one input zone.

In accordance with a preferred embodiment of the present invention a light source is provided which generates a light beam, and beam-moving apparatus is provided which moves the light beam to generate the optically generated image of the data input device.

Further in accordance with a preferred embodiment of the present invention the beam-moving apparatus includes a mirror arranged to reflect the light beam, and an actuator operatively connected to the mirror, wherein the actuator moves the mirror to reflect the light beam to form at least a two-dimensional image of the data input device.

Still further in accordance with a preferred embodiment of the present invention the beam-moving apparatus includes a scanner arranged to scan the light beam, and an actuator operatively connected to the scanner, wherein the actuator moves the scanner to scan the light beam in order to form at least a two-dimensional image of the data input device.

In accordance with a preferred embodiment of the present invention the data input device may include a key of a keyboard, a keyboard, a mouse with at least one input button or a key of a touch pad.

Further in accordance with a preferred embodiment of the present invention the sensor may include an optical sensor (such as a CCD or PSD), an acoustic sensor or a movement sensor.

Still further in accordance with a preferred embodiment of the present

In accordance with a preferred embodiment of the present invention the optical image of the data input device is generated by employing a single laser source and using color and wavelength splitters to split light from the single laser source.

Further in accordance with a preferred embodiment of the present invention the optical image of the data input device is generated by means of differently polarized light beams.

In accordance with a preferred embodiment of the present invention the step of sensing includes detecting light reflected from an object within a silhouette of the image, and analyzing a reflection of the light to determine a spatial position of the object.

Further in accordance with a preferred embodiment of the present invention the step of sensing includes providing a light beam emanating from a light source, detecting light reflected from an object within a silhouette of the image, corresponding to the light beam, and analyzing an angle of the light beam and a time for the beam to be reflected back from the object to a reference to determine a spatial position of the object.

Still further in accordance with a preferred embodiment of the present invention the reference includes an optically readable reference.

Additionally in accordance with a preferred embodiment of the present invention the optically readable reference includes a tangible bar code strip or an optically generated bar code strip.

In accordance with a preferred embodiment of the present invention the optical image of a data input device is generated by the same light beam whose reflection is used to determine the spatial position of the object.

Further in accordance with a preferred embodiment of the present invention the step of sensing includes providing a non-visible-light beam emanating from a non-visible-light source, detecting an image of the non-light impinging upon an object within a silhouette of the image of the data input device, and analyzing the image of the non-light to determine a spatial position of the object.

Still further in accordance with a preferred embodiment of the present invention the non-visible-light beam includes an infrared beam and the image of the non-light includes an infrared image of the object.

In accordance with a preferred embodiment, the projector includes a point light source illuminating a mask defining the image of at least part of a keyboard.

Preferably, the apparatus also includes a mirror directing light passing through the mask onto the inert surface. Preferably, the apparatus also includes at least one lens directly light from the point source through the mask.

In a preferred embodiment the point light source includes a diode laser.

Preferably the mask is formed to define a distorted representation of the image of the at least part of a keyboard in order to compensate for distortions in the projector.

In another preferred embodiment the mask is a dynamically changeable mask.

In another preferred embodiment the infra-red illuminator includes a cylindrical reflecting element receiving light from a point source and producing a generally flat, generally radially-directed light distribution.

In another preferred embodiment at least one sensor includes an array of discrete sensing elements and at least one lens operative to image a region overlying each of a plurality of keyboard locations onto a corresponding at least one of the array of discrete sensing elements. Preferably, the at least one sensor includes an a position sensitive detector and at least one lens operative to image a region overlying each of a plurality of keyboard locations onto a corresponding region on the position sensing detector.

In another preferred embodiment the at least one infra-red illuminator is operative to direct infra-red radiation at a plurality of levels over the image of at least part of a keyboard and the at least one infra-red sensor is operative to sense infra-red light scattered from at least one user indicator at a plurality of locations therealong.

In another preferred embodiment the projector includes a diffractive optical element, which when illuminated produces the image of at least part of a keyboard onto the inert surface.

Preferably the projector includes a spatial light modulator, which when illuminated produces the image of at least part of a keyboard onto the inert surface.

Preferably the spatial light modulator includes a dynamic spatial light modulator which is responsive to an electrical input for producing a dynamic image

at least one projector mounted on the wireless communicator and projecting an image of a display onto a surface.

In accordance with another preferred embodiment of the present invention there is provided a wireless system for e mail communication which also includes:

a wireless communicator providing e mail communication functionality;

at least one projector mounted on the wireless communicator and projecting an image of at least part of a keyboard onto a surface.

Preferably the wireless system for e mail communication also includes:

at least one sensor, sensing user indicator interaction with specific locations on the image of at least part of a keyboard; and

at least alpha-numeric information generation circuitry employing an output from the at least one sensor for providing an at least alpha-numeric output.

Preferably the wireless system for e mail communication is also operative for projecting an image of a display onto a surface, whereby a user may readily view messages during e mail communication.

Preferably the wireless system for e mail communication also includes at least one sensor, sensing user indicator interaction with specific locations on the image of the display; and e-mail communication input circuitry employing an output from the at least one sensor for providing an at least one e mail communication output based on user implement actuation of locations on the image of the display.

In accordance with another preferred embodiment of the present invention there is provided a wireless system for mobile commerce communication that also includes:

a wireless communicator providing mobile commerce communication functionality; and

at least one projector mounted on the wireless communicator and projecting an image of a display onto a surface.

Preferably the wireless system for mobile commerce communication also includes

at least one sensor, sensing user indicator interaction with specific locations on the image of at least part of a keyboard; and

Fig. 1 is a simplified pictorial illustration of a system for data input constructed and operative in accordance with a preferred embodiment of the present invention;

Fig. 2 is a simplified block diagram of a the system for the data input device of Fig. 1;

Figs. 3A - 3E are simplified pictorial illustrations of optically generated images of data input devices, constructed and operative in accordance with different preferred embodiments of the present invention;

Fig. 4A is a simplified pictorial illustration of beam-moving apparatus constructed and operative in accordance with a preferred embodiment of the present invention, including a mirror array with actuators for moving the array;

Fig. 4B is a simplified pictorial illustration of beam-moving apparatus useful in accordance with another preferred embodiment of the present invention, including a crystal beam modifier;

Fig. 4C is a simplified pictorial illustration of beam-moving apparatus constructed and operative in accordance with yet another preferred embodiment of the present invention, including a scanner;

Fig. 5 is a simplified pictorial illustration of a data input device constructed and operative in accordance with another preferred embodiment of the present invention, including a light unit that projects an optical image of a data input device by projecting light from underneath a transparent or translucent substrate;

Fig. 6 is a simplified illustration of a multilingual keyboard, constructed and operative in accordance with a preferred embodiment of the present invention;

Fig. 7 is a simplified illustration of a non-standard layout of keys on an optically generated image of a keyboard, wherein a user can modify the arrangement, size and shape of the "virtual" keys, in accordance with a preferred embodiment of the present invention;

Fig. 8 is a simplified illustration of an optical sensor system for sensing input of data in any of the data input devices of the invention, constructed and operative in accordance with a preferred embodiment of the present invention, which uses two light beams to determine the position of the object defining the data input;

Fig. 9A is a simplified illustration of a light beam passing over the

of the present invention;

Fig. 20 is a simplified pictorial illustration of a personal digital assistant including a projected keyboard functionality in accordance with a preferred embodiment of the present invention;

Fig. 21 is a simplified partially pictorial, partially schematic illustration of projection, illumination, detection and information processing functionality useful in the embodiments of Figs. 19 and 20;

Fig. 22 is an another illustration of the projection functionality of Fig. 21;

Fig. 23 is a somewhat more detailed illustration of the illumination functionality of Fig. 21 in accordance with a preferred embodiment of the present invention;

Fig. 24 is a somewhat more detailed illustration of the detection functionality of Fig. 21 in accordance with a preferred embodiment of the present invention;

Fig. 25 is a simplified pictorial illustration of a pre-distorted projection mask useful in the functionality of Figs. 21 and 22;

Fig. 26 is a somewhat more detailed illustration of the detection functionality of Fig. 21 in accordance with another preferred embodiment of the present invention and providing detection in three dimensions;

Fig. 27 is a somewhat more detailed illustration of the projection functionality of Fig. 21 in accordance with another preferred embodiment of the present invention;

Fig. 28 is a somewhat more detailed illustration of the projection functionality of Fig. 21 in accordance with yet another preferred embodiment of the present invention and providing dynamic projection;

Fig. 29 is a simplified pictorial illustration of a mobile web browsing functionality employing an embodiment of the present invention;

Fig. 30 is a simplified pictorial illustration of an interactive mobile computing functionality employing an embodiment of the present invention; and

Fig. 31 is a simplified pictorial illustration of an interactive mobile web functionality employing an embodiment of the present invention.

one of keys or buttons 38 can generate mathematical functions or alphanumeric characters. The pad keys 34 or keys 38 are also examples of "virtual" PDA switches that can be optically generated. Of course, any suitable kind of switch can be optically generated, such as single-pole and multi-pole switches, for example.

A sensor is preferably provided to sense the above described actions performed on the input zone 19. Many kinds of sensors can be employed to detect pressing any of the "virtual" keys of the embodiments shown in Figs. 3A-3E. For example, as seen in Fig. 1, the sensor may be an optical sensor 40, such as an electronic camera, CCD or position sensing device (PSD), whose field of view encompasses the "virtual" keyboard or touch pad, etc. Other examples of suitable sensors include an acoustic sensor 42 and a position or movement sensor 44. Three acoustic sensors 42 should preferably be used for sensing the action by means of triangulation. Any number of position or movement sensors can be used, and more than one kind of sensor can be employed in carrying out the invention. Other examples of suitable sensors are described hereinbelow with reference to Figs. 8-10.

The sensors, upon sensing the "pressing" or "striking" of the "virtual" keys, preferably generate electrical signals based upon the sensed information and transmit the signal to a processor 50 which processes and interprets the signals into the desired characters, instructions, information and data, input by the user. Processor 50 is preferably in electrical communication with a device, such as a computer 52, mobile telephone 54, musical instrument 56, palm-held computer/calculator 58, and the like, which visually or audibly outputs the desired characters, instructions, information and data.

In accordance with a preferred embodiment of the present invention, as shown in Fig. 4A, beam-moving apparatus 16 includes a mirror array 60 (one or more mirrors) arranged to reflect light beam 14, and an actuator, such as a servomotor 62, operatively connected to mirror array 60. Servomotor 62 preferably rapidly moves mirror array 60 to reflect light beam 14 to form an image of data input device 10. Another example is shown in Fig. 4B, wherein beam-moving apparatus 16 includes a crystal beam modifier 64. Fig. 4C illustrates yet another example of beam-moving apparatus 16, that of a scanner 66. In all cases, light beam 14 is rapidly moved to form an image of the data input device 10. Alternatively, a holographic image of data input

example, as shown in Fig. 6, laser unit 68 can first display a standard "qwertyuiop" layout of keys 82 in English. The user can then type in English the desired language, other than English, whereupon the processor 86 recognizes the desired language and signals the laser unit 68 to generate a different set of key patterns 88 and text 84 formed in the outline of each key 82.

Additionally or alternatively, switches 90 may be provided for switching between languages. It is important to note that the different set of keys 88 does not necessarily have the same amount or layout as the standard "qwertyuiop" layout of keys 82 in English. Linguistic processor 86 is also operative to interpret between the keyed-in language and any other language in which it is desired to transmit a message. For example, a Japanese user interested in a website of a Hungarian company, can command laser unit 68 to generate an optical image of a Japanese keyboard, and type a message in Japanese. Linguistic processor 86 then translates the Japanese message into Hungarian, and directs the translated message to the website.

It is noted that linguistic processor 86 may be locally connected to data input device 10, and may be part of its hardware. Alternatively, linguistic processor 86 can be provided on a remote server, and remotely accessed via the internet. The latter feature enables having an international linguistic interface for global communication.

Reference is now made to Fig. 7 which illustrates that laser unit 68 can display a non-standard layout of keys 92. In accordance with a preferred embodiment of the present invention, the user can modify the arrangement, size and shape of keys 92, such as by typing in commands which are interpreted and processed by processor 50 to generate the desired arrangement. Additionally or alternatively, switches 94 or other hardware may be provided for selecting an arrangement of keys 92.

Reference is now made to Fig. 8 which illustrates an optical sensor system 100 for sensing input of data in any of the data input devices of the present invention, constructed and operative in accordance with a preferred embodiment of the present invention. Optical sensing system 100 preferably includes two light beams 102 and 104, different from light beam 14, to determine the position of the data input. Light beams 102 and 104 may emanate from light source 12 or from one or more additional light sources 106. Light beams 102 and 104 preferably cover the entire area of image 18, either by means of scanning or by having sufficient beam width to cover the entire

time data for light beams 122 and derives the spatial position of the finger. Finally, when the finger moves to press the particular key, such as key 126, the movement of the finger causes a different reflection of light beam 122. The new reflection is analyzed to sense which key 126 was "pressed".

Reference is now made to Fig. 11 which illustrates an optical sensor system 130 for sensing input of data in any of the data input devices of the present invention, constructed and operative in accordance with yet another preferred embodiment of the present invention. Optical sensing system 130 is preferably similar to the previously described optical sensing system 120, with like elements being designated by like numerals.

In optical sensing system 120, light source 12 or 106 is preferably located at a fixed, known distance from keyboard 124 in order to determine the distance to the particular finger or object. Optical sensing system 130 differs from optical sensing system 120 in that sensing system 130 preferably uses an optically readable reference 132, such as a bar code, as a reference for determining the distance to the particular finger or object. Optically readable reference 132 may be a tangible bar code strip placed on a working surface by the user. Alternatively, optically readable reference 132 may be optically generated just like keyboard 124.

For a given angle, such as angle β, light beam 122 not only crosses over a plurality of keys 126, but also impinges upon a particular region of optically readable reference 132. The particular place of impingement on optically readable reference 132 determines the angle of light beam 122. Processor 50 can proceed to analyze the angle and time data for light beams 122 and derive the spatial position of the finger, as described hereinabove with reference to Figs. 9A, 9B and 10.

The embodiments of Figs. 8 - 11 have been described such that the light beams 102, 104 and 122 used to sense the input of data are different from the light beam 14 used to create the virtual keyboard. Alternatively, with appropriate circuitry or software, light beam 14 itself can be used as the light beam used to sense the input of data.

Reference is now made to Fig. 12 which illustrates a sensor system 140 for sensing input of data in any of the input devices of the present invention, constructed and operative accordance with yet another preferred embodiment of the present

light beam 14, processor 50 can instruct moving apparatus 16 and source 12 to cause light beam 14 to generate the image 18 only in those regions not covered by the fingers.

It is noted that any of the above-described sensor systems 100, 120, 130 or 140 can be used to detect data input and the like even without being used in conjunction with the generation of image 18. For example, any of the sensor systems of the invention can be used to detect finger movement on a "regular", tangible keyboard.

Reference is now made to Figs. 16 and 17 which illustrate other examples of applications generating images of data input devices in accordance with preferred embodiments of the present invention. In Fig. 16, a light-generated web page is generated with any of the above-described apparatus for generating images of data input devices. A user can input data by "clicking" on a click zone 148, the click being detected as described hereinabove.

In Fig. 17, a light-generated game object 150, such as a chess piece 152 and chess board 154 are generated with any of the above-described apparatus for generating images of data input devices. A user can input data related to the game, such as "moving" the chess piece 152, with the input being detected as described hereinabove.

As mentioned hereinabove, laser unit 68 is considered the most preferred embodiment, but other light units can be used to generate the optical image of the data input device. Another example is shown in Fig. 18, mirror array 60 (described hereinabove with reference to Fig. 4A) may include a mirror 160 with a darkened portion 162 that does not reflect light, and clear portions 164 which do reflect light. The clear portions 164 are shaped like characters, numerals, letters or any other shape which it is desired to form a light-generated image 166 thereof.

Reference is now made to Fig. 19, which is a simplified pictorial illustration of a mobile telephone or other suitable mobile communicator, referred to collectively as a mobile telephone, including a projected keyboard functionality in accordance with a preferred embodiment of the present invention.

As seen in Fig. 19, a modified mobile telephone 200, such as a cellular telephone may be modified to include a projector 202, which is capable of projecting an image 204 of at least part of a keyboard onto an inert surface 206, such as a desktop. At least one sensor 208, such as a CCD or CMOS camera mounted on mobile telephone

illustration of projection, illumination and detection functionality useful in the embodiments of Figs. 19 and 20 and to Figs. 22, 23 and 24 which show more details thereof.

As seen in Figs. 21 and 22, in a modified mobile device 250, such as modified telephone 200 (Fig. 19) or a modified personal digital assistant 220 (Fig. 20), a projector 252, such as projector 202 (Fig. 19) or projector 222 (Fig. 20) preferably includes a solid state point light source 254 which illuminates a mask 256 which defines an image 258 of a keyboard and a mouse functionality, preferably including a touchpad 284 and a pair of click buttons 286 and 288, preferably via a negative lens 260. A mirror 262 preferably directs light that has passed through mask 256 onto a projection surface 264, preferably an inert surface, such as a desktop. It is noted that the natural astigmatism of a diode laser light source may be used to advantage in order to obviate the need for a condensing lens upstream of mask 256.

Mask 256 may be any suitable type of mask and is preferably designed to be pre-distorted, as shown in Fig. 25 in order to compensate for optical distortions in projection and to enable a generally distortion free image of a keyboard to be projected onto an inert surface.

As seen in Figs. 21 and 23, in modified mobile device 250, an illuminator 272, such as illuminator 212 (Fig. 19) or illuminator 232 (Fig. 20) preferably includes a solid state light source 274 which directs light via a focusing lens 276 and a mirror 278 onto a cylindrical reflecting element 280, which preferably produces radially directed illumination 283 about a longitudinal axis 281 of the cylindrical reflecting element 280. The radially directed illumination 283 extends over approximately 180 degrees, generally in a plane generally parallel to the projection surface 264. It is appreciated that the radially directed illumination 283 has a very narrow spread in the direction generally perpendicular to the projection surface 264. It is further appreciated that the radially directed illumination 283 is located very close to the surface of the projection surface 264.

Impingement of the radially directed illumination 283 on a stylus 282 or other use implement or appendage causes light to be scattered or reflected therefrom. It is appreciated that the light is only reflected when the stylus is in close contact with the keyboard 224.

light reflected or scattered from a stylus 310. In the embodiment of Fig. 26, the output of detector 308 and a position indicating output from the scanning mirror 300 are supplied to 3-D position calculation circuitry 312, which correlates the detection of the stylus with the position of the light plane 304. X and Y coordinates of the position of the stylus 310 are determined from the output of the detector 308 while the Z position of the tip of the stylus is determined from the position of the scanning mirror 300 when the light from the stylus is first detected. In this way, the location of the tip of the stylus may be determined to a desired degree of accuracy notwithstanding that the stylus is not in contact with a reference surface, such as surface 306.

Reference is now made to Fig. 27, which is a somewhat more detailed illustration of the projection functionality of Fig. 21 in accordance with another preferred embodiment of the present invention. As seen in Fig. 27, a projector 320, such as projector 202 (Fig. 19) or projector 222 (Fig. 20) preferably includes a solid state point light source 322 which illuminates a diffractive optical element 324, which defines an image 326 of a keyboard, preferably via a lens (not shown).

Reference is now made to Fig. 28, which is a somewhat more detailed illustration of the projection functionality of Fig. 21 in accordance with yet another preferred embodiment of the present invention and providing dynamic projection. As seen in Fig. 28 one or more solid state light sources 332 direct light through a condensing lens 334 onto a dynamic mask 336, such as a spatial light modulator, which receives a modulating input from an image generator 338.

The dynamically modulated light output from dynamic mask 336 passes through a projection lens 340 and preferably is reflected by a mirror 342 onto a surface 344, thereby defining an image 346 of a keyboard on surface 344. It is appreciated that the image of the keyboard may be varied by changing the modulation of the dynamic mask 336, to accommodate different fonts, languages or specific user requirements and to provide a selectable and variable touch screen. In this manner a user interface may be partially or entirely provided using the projected image provided using the dynamic mask 336.

Reference is now made to Fig. 29, which is simplified pictorial illustration of a mobile web browsing functionality employing an embodiment of the present invention. As seen in Fig. 29, a suitably equipped mobile communicator, such as

foregoing description and which are not in the prior art.

sensing infra-red light scattered from at least one user indicator.

8. Apparatus according to claim 2 and wherein said at least one sensor comprises at least one infra-red illuminator, directing infra-red radiation over said image of at least part of a keyboard onto an inert surface and at least one infra-red sensor for sensing infra-red light reflected from at least one user indicator.

9. Apparatus according to claim 3 and wherein said at least one sensor comprises at least one visible light illuminator, directing visible radiation over said image of at least part of a keyboard onto an inert surface and at least one visible radiation sensor for sensing visible light scattered from at least one user indicator.

10. Apparatus according to claim 4 and wherein said at least one sensor comprises at least one visible light illuminator, directing visible radiation over said image of at least part of a keyboard onto an inert surface and at least one visible radiation sensor for sensing visible light reflected from at least one user indicator.

11. Apparatus according to claim 1 and wherein said user indicator is a user finger.

12. Apparatus according to claim 1 and wherein said user indicator is a user held stylus.

13. Apparatus according to claim 1 and wherein said projector comprises a point light source illuminating a mask defining said image of at least part of a keyboard.

14. Apparatus according to claim 13 and also comprising a mirror directing light passing through said mask onto said inert surface.

15. Apparatus according to claim 13 and also comprising at least one lens directly light from said point source through said mask.

comprises an a position sensitive detector and at least one lens operative to image a region overlying each of a plurality of keyboard locations onto a corresponding region on said position sensing detector.

25. Apparatus according to claim 7 and wherein said at least one infra-red illuminator is operative to direct infra-red radiation at a plurality of levels over said image of at least part of a keyboard and said at least one infra-red sensor is operative to sense infra-red light scattered from at least one user indicator at a plurality of locations therealong.

26. Apparatus according to claim 8 and wherein said at least one infra-red illuminator is operative to direct infra-red radiation at a plurality of levels over said image of at least part of a keyboard and said at least one infra-red sensor is operative to sense infra-red light reflected from at least one user indicator at a plurality of locations therealong.

27. Apparatus according to claim 9 and wherein said at least one visible radiation illuminator is operative to direct visible radiation at a plurality of levels over said image of at least part of a keyboard and said at least one visible radiation sensor is operative to sense visible radiation light scattered from at least one user indicator at a plurality of locations therealong.

28. Apparatus according to claim 10 and wherein said at least one visible radiation illuminator is operative to direct visible radiation at a plurality of levels over said image of at least part of a keyboard and said at least one visible radiation sensor is operative to sense visible radiation light reflected from at least one user indicator at a plurality of locations therealong.

29. Apparatus according to claim 1 and wherein said projector comprises a diffractive optical element, which when illuminated produces said image of at least part of a keyboard onto said inert surface.

36. A wireless system for web browsing comprising:

a wireless communicator providing web browsing functionality:

at least one projector mounted on said wireless communicator and projecting an image of at least part of a keyboard onto a surface;

at least one sensor, sensing user indicator interaction with specific locations on said image of at least part of a keyboard; and

at least alpha-numeric information generation circuitry employing an output from said at least one sensor for providing an at least alpha-numeric output.

37. A wireless system for web browsing according to claim 36 and wherein said projector is also operative for projecting an image of a display onto a surface, whereby a user may readily view images produced during web browsing.

38. A wireless system for web browsing according to claim 37 and also comprising:

at least one sensor, sensing user indicator interaction with specific locations on said image of said display; and

web browsing input circuitry employing an output from said at least one sensor for providing an at least one web browsing output based on user implement actuation of locations on said image of said display corresponding to web links.

39. A wireless system for email communication comprising:

a wireless communicator providing email communication functionality: and

at least one projector mounted on said wireless communicator and projecting an image of a display onto a surface.

40. A wireless system for email communication comprising:

a wireless communicator providing e mail communication functionality:

at least one projector mounted on said wireless communicator and projecting an image of at least part of a keyboard onto a surface.

and projecting an image of at least part of a keyboard onto a surface.

46. A wireless system for mobile commerce communication comprising:

a wireless communicator providing mobile commerce communication functionality:

at least one projector mounted on said wireless communicator and projecting an image of at least part of a keyboard onto a surface;

at least one sensor, sensing user indicator interaction with specific locations on said image of at least part of a keyboard; and

at least alpha-numeric information generation circuitry employing an output from said at least one sensor for providing at least an mobile commerce communication output.

47. A wireless system for mobile commerce communication according to claim 46 and wherein said projector is also operative for projecting an image of a display onto a surface, whereby a user may readily view images produced during mobile commerce communication.

48. A wireless system for mobile commerce communication according to claim 47 and also comprising:

at least one sensor, sensing user indicator interaction with specific locations on said image of said display; and

mobile commerce communication input circuitry employing an output from said at least one sensor for providing an at least one mobile commerce communication output based on user implement actuation of locations on said image of said display corresponding to web links.

49. A method for inputting at least alpha-numeric information into a computer comprising:

projecting an image of at least part of a keyboard onto an inert surface;

sensing user indicator interaction with specific locations on said image of at least part of a keyboard; and

58. A method according to claim 49 and wherein said sensing comprises position sensitive detecting and imaging of a region overlying each of a plurality of keyboard locations onto a corresponding region on said position sensing detector.

59. A method according to claim 51and wherein said directing includes directing infra-red radiation at a plurality of levels over said image of at least part of a keyboard and said infra-red sensing includes sensing infra-red light scattered from at least one user indicator at a plurality of locations therealong.

60. A method according to claim 52 and wherein said directing includes directing visible radiation at a plurality of levels over said image of at least part of a keyboard and said visible sensing includes sensing visible light scattered from at least one user indicator at a plurality of locations therealong.

61. A method according to claim 49 and wherein said projecting comprises illuminating a diffractive optical element to produce said image of at least part of a keyboard onto said inert surface.

62. A method according to claim 49 and wherein said projecting comprises illuminating a spatial light modulator to produce said image of at least part of a keyboard onto said inert surface.

63. A method according to claim 62 and wherein said projecting comprises illuminating a dynamic spatial light modulator which is responsive to an electrical input for producing a dynamic image onto said inert surface.

64. A method for wireless web browsing comprising:

providing web browsing functionality: and

projecting an image of a display related to said functionality onto a surface.

projecting an image of at least part of a keyboard onto a surface for use in said communication functionality.

71. A method for wireless e mail communication comprising:

providing e mail communication functionality;

projecting an image of at least part of a keyboard onto a surface;

sensing user indicator interaction with specific locations on said image of at least part of a keyboard; and

generating an output from said at least one sensor for providing an at least alpha-numeric output useful in said communication functionality.

72. A method for wireless e mail communication according to claim 71 and wherein said projection comprises projecting an image of a display onto a surface, whereby a user may readily view messages during e mail communication.

73. A method for wireless e mail communication according to claim 72 and also comprising:

sensing user indicator interaction with specific locations on said image of said display; and

employing an output from said sensing for providing an at least one e mail communication output based on user implement actuation of locations on said image of said display.

74. A method for wireless mobile commerce communication comprising:

providing mobile commerce communication functionality: and

projecting an image of a display onto a surface for use in said communication functionality.

75. A method for wireless mobile commerce communication comprising:

providing mobile commerce communication functionality; and

projecting an image of at least part of a keyboard onto a surface.

at least said mouse functionality; and

generating an output from said at least one sensor for providing an at least a cursor control output.

81. A data input device comprising:

an optically generated image of a data input device, said image comprising at least one input zone actuable by an action performed thereon by a user;

a sensor operative to sense the action performed on said at least one input zone, and to generate signals in response to said action; and

a processor in communication with said sensor operative to process said signals for performing an operation associated with said at least one input zone.

82. The device according to claim 81 and further comprising a light source which generates a light beam, and beam-moving apparatus which moves said light beam to generate said optically generated image of said data input device.

83. The device according to claim 82 wherein said beam-moving apparatus comprises a mirror arranged to reflect said light beam.

84. The device according to claim 83 and further comprising an actuator operatively connected to said mirror, wherein said actuator moves said mirror to reflect said light beam to form at least a two-dimensional image of said data input device.

85. The device according to claim 82 wherein said beam-moving apparatus comprises a scanner arranged to scan said light beam, and an actuator operatively connected to said scanner, wherein said actuator moves said scanner to scan said light beam to form at least a two-dimensional image of said data input device.

86. The device according to claim 81 wherein said data input device comprises a key of a keyboard.

87. The device according to claim 81 wherein said data input device

comprising at least one input zone actuable by an action performed thereon by a user;

performing an action on said at least one input zone;

sensing the action performed on said at least one input zone;

generating signals in response to said action; and

processing said signals for performing an operation associated with said at least one input zone.

98. The method according to claim 97 wherein the step of generating the optical image comprises generating an image of a keyboard and the step of performing an action comprises pressing keys of said image of said keyboard.

99. The method according to claim 98 wherein the step of processing said signals causes typing alphanumeric characters on at least one of a computer, cell phone, palm-sized computer/calculator and PDA.

100. The method according to claim 98 and further comprising modifying said image of said keyboard so as to modify a configuration of keys of said keyboard.

101. The method according to claim 98 and further comprising:

optically generating an image of characters of a first language on keys of said keyboard;

selecting a second language different from said first language; and

optically generating an image of characters of said second language on keys of said keyboard.

102. The method according to claim 97 wherein said optical image of said data input device is a holographic image.

103. The method according to claim 97 wherein said optical image of said data input device is generated by means of a monochromatic laser.

104. The method according to claim 97 wherein said optical image of said

111. The method according to claim 109 wherein said optically readable reference comprises an optically generated bar code strip.

112. The method according to claim 108 wherein said optical image of a data input device is generated by the same light beam whose reflection is used to determine the spatial position of the object.

113. The method according to claim 97 wherein the step of sensing comprises:

providing a non-visible-light beam emanating from a non-visible light source;

detecting an image of said non-visible light impinging upon an object within a silhouette of said image of the data input device; and

analyzing said image of said non-visible light to determine a spatial position of the object.

114. The method according to claim 113 wherein said non-visible light beam comprises an infrared beam and said image of said non-visible light comprises an infrared image of said object.

115. The method according to claim 97 and further comprising detecting light reflected from an object within a silhouette of said image and preventing said image from impinging upon said object.

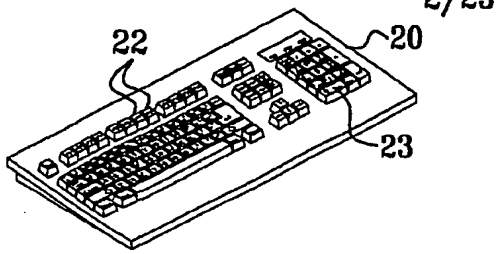


FIG. 3A

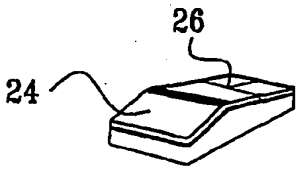


FIG. 3B

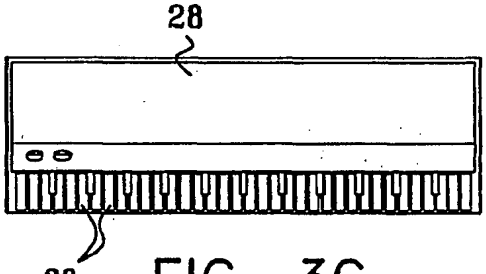


FIG. 3C

FIG. 3D

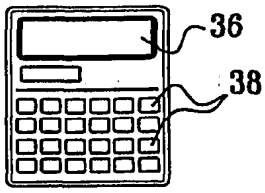


FIG. 3E

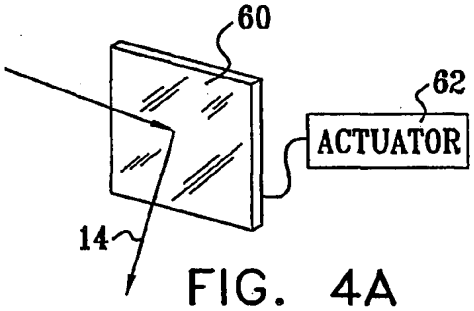


FIG. 4A

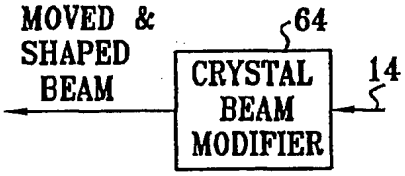


FIG. 4B

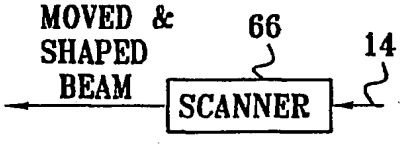


FIG. 4C

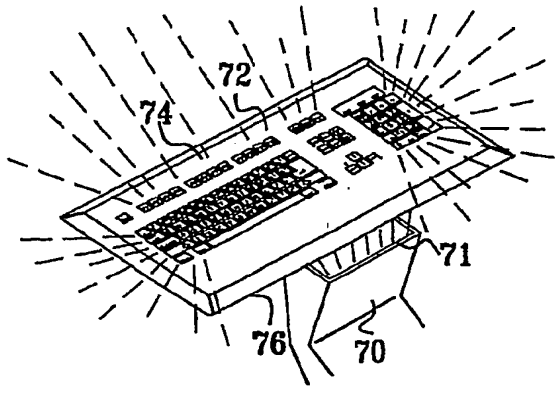


FIG. 5

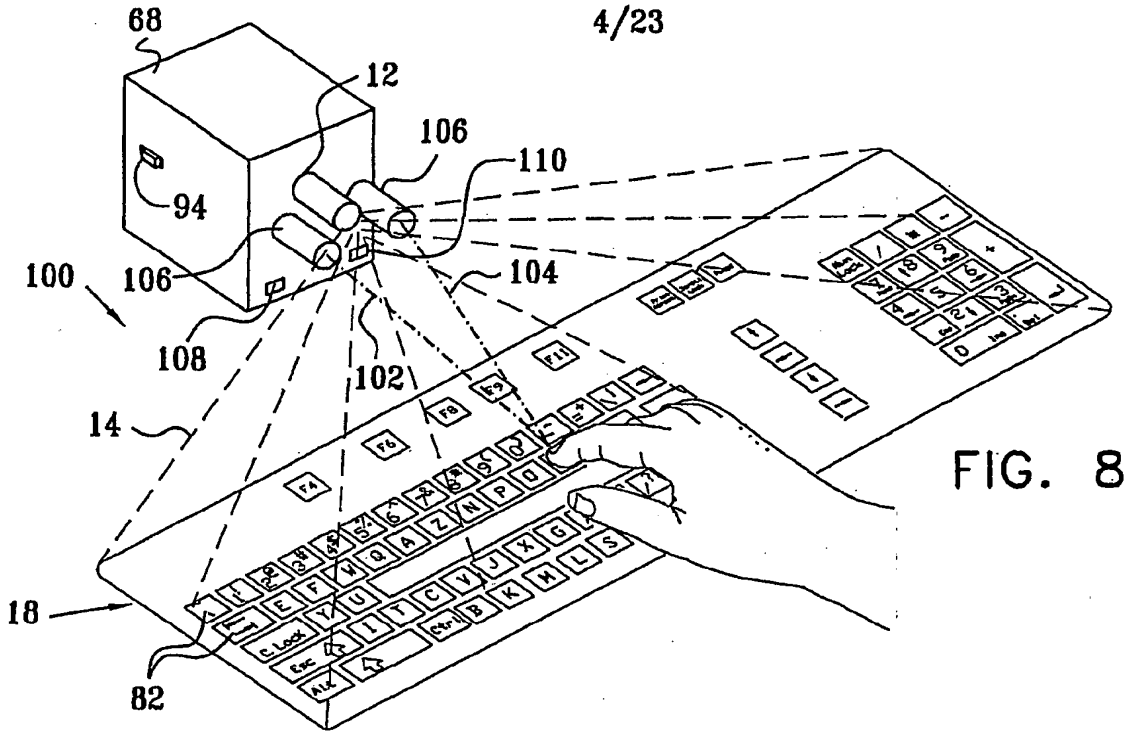


FIG. 8

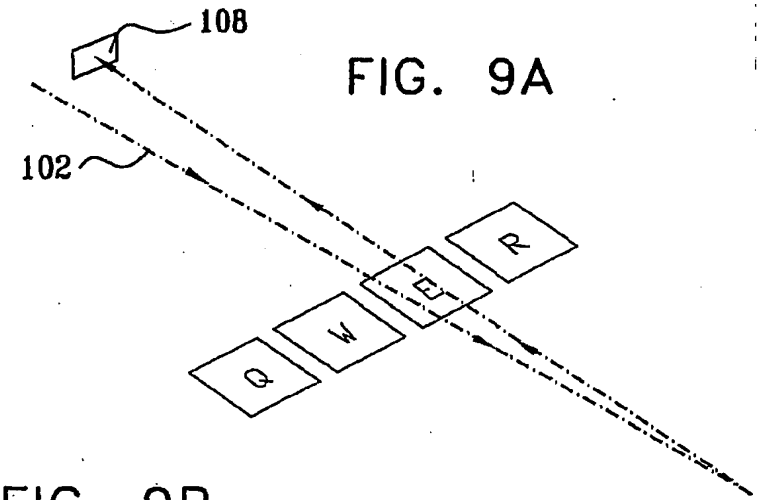


FIG. 9A

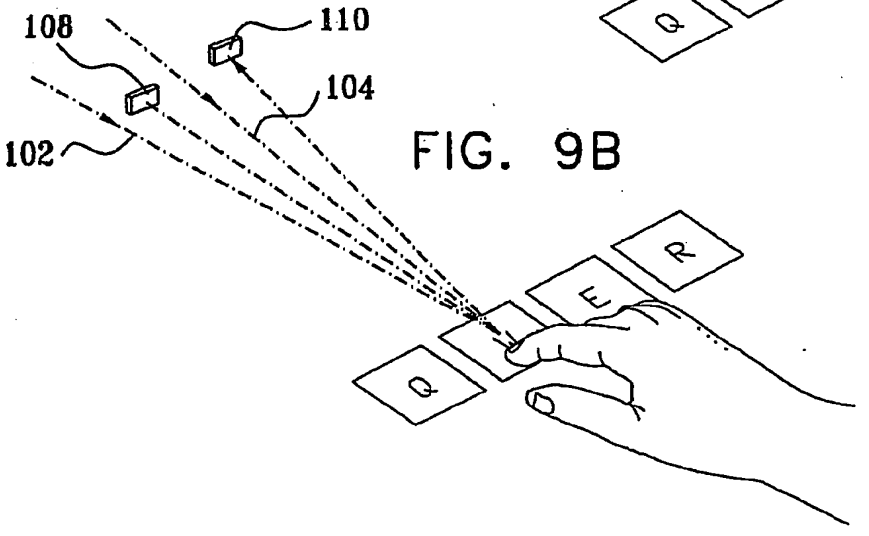
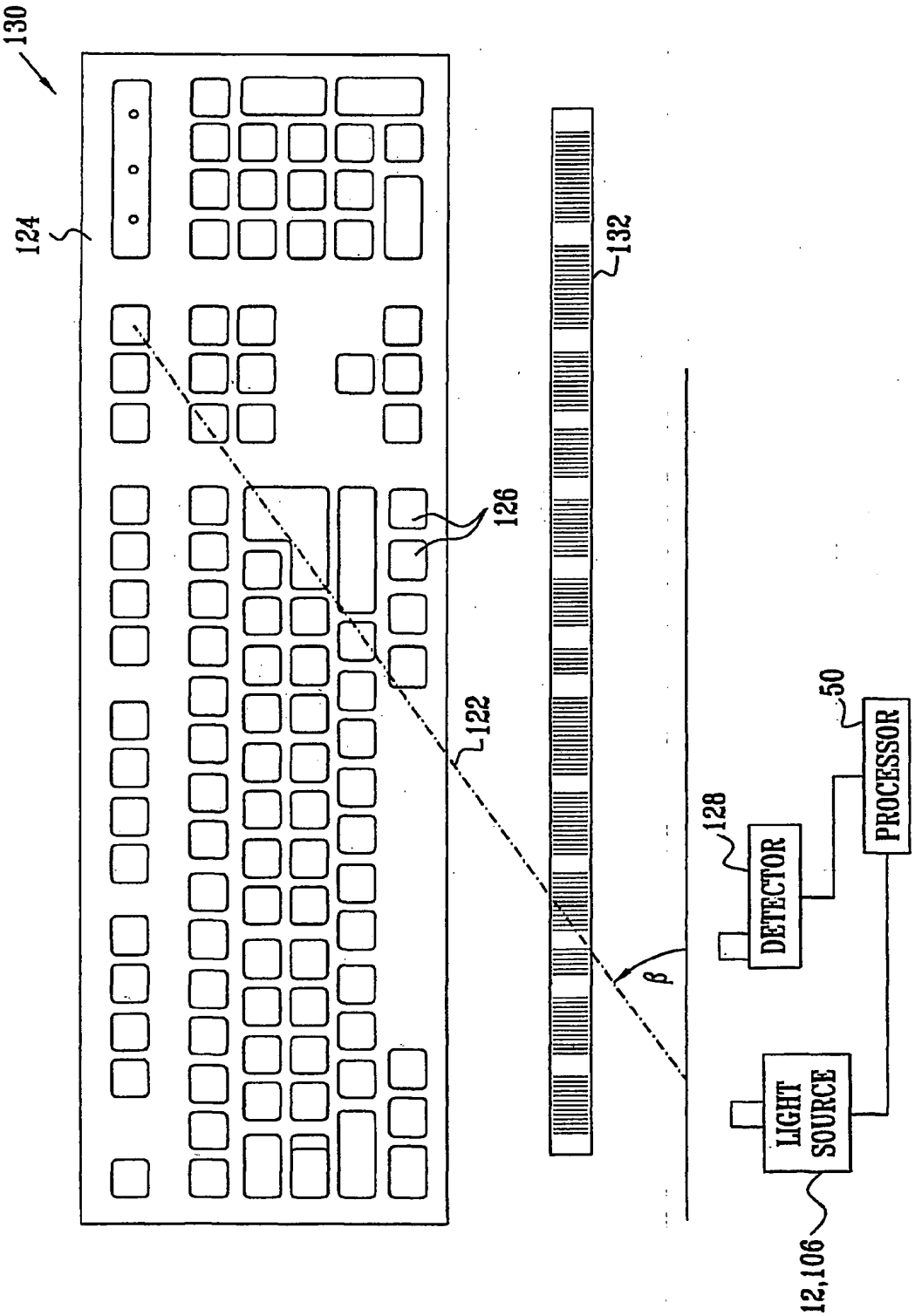


FIG. 9B

FIG. 11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DETECTOR
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PROCESSOR
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LIGHT SOURCE
12,106

FIG. 14

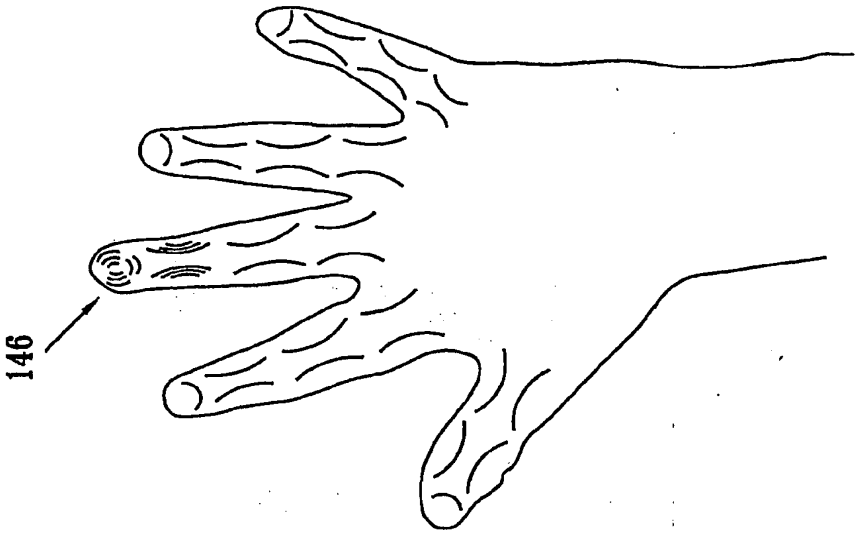
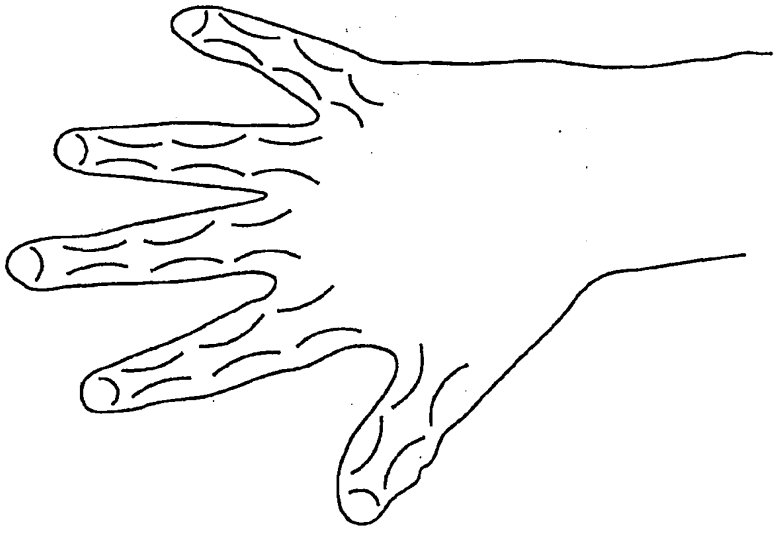


FIG. 13



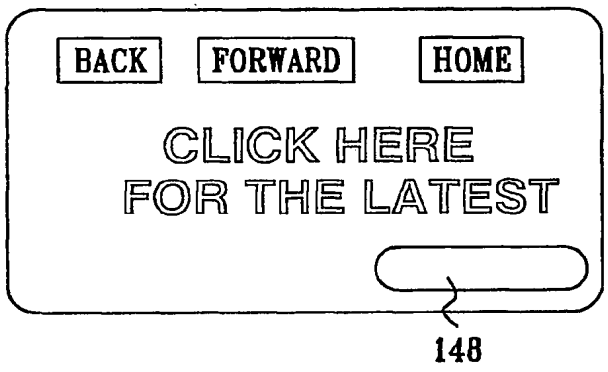


FIG. 16

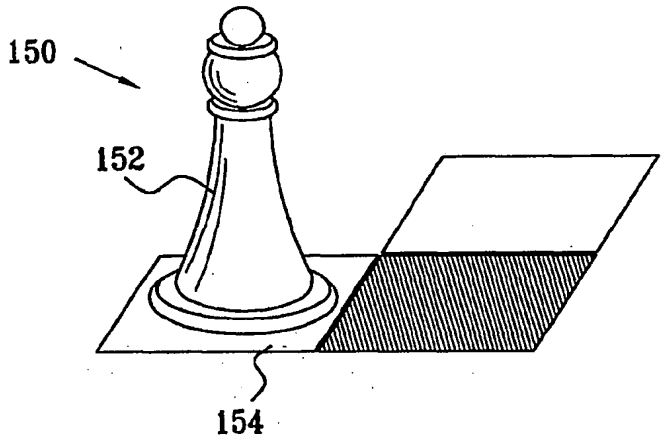


FIG. 17

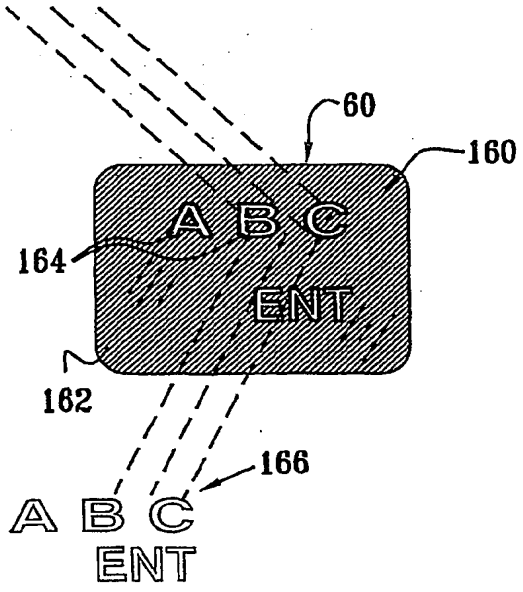
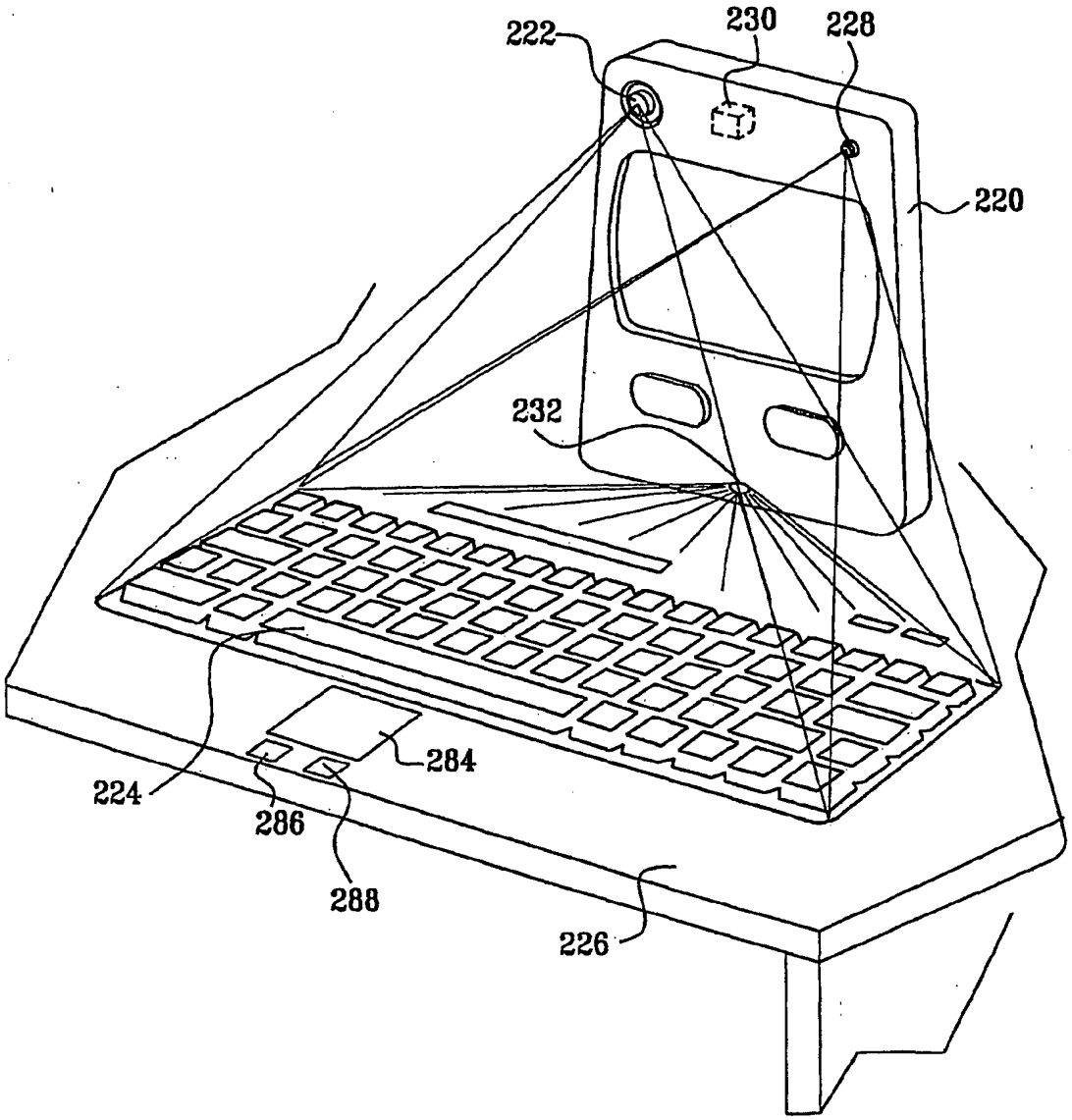


FIG. 18

FIG. 20



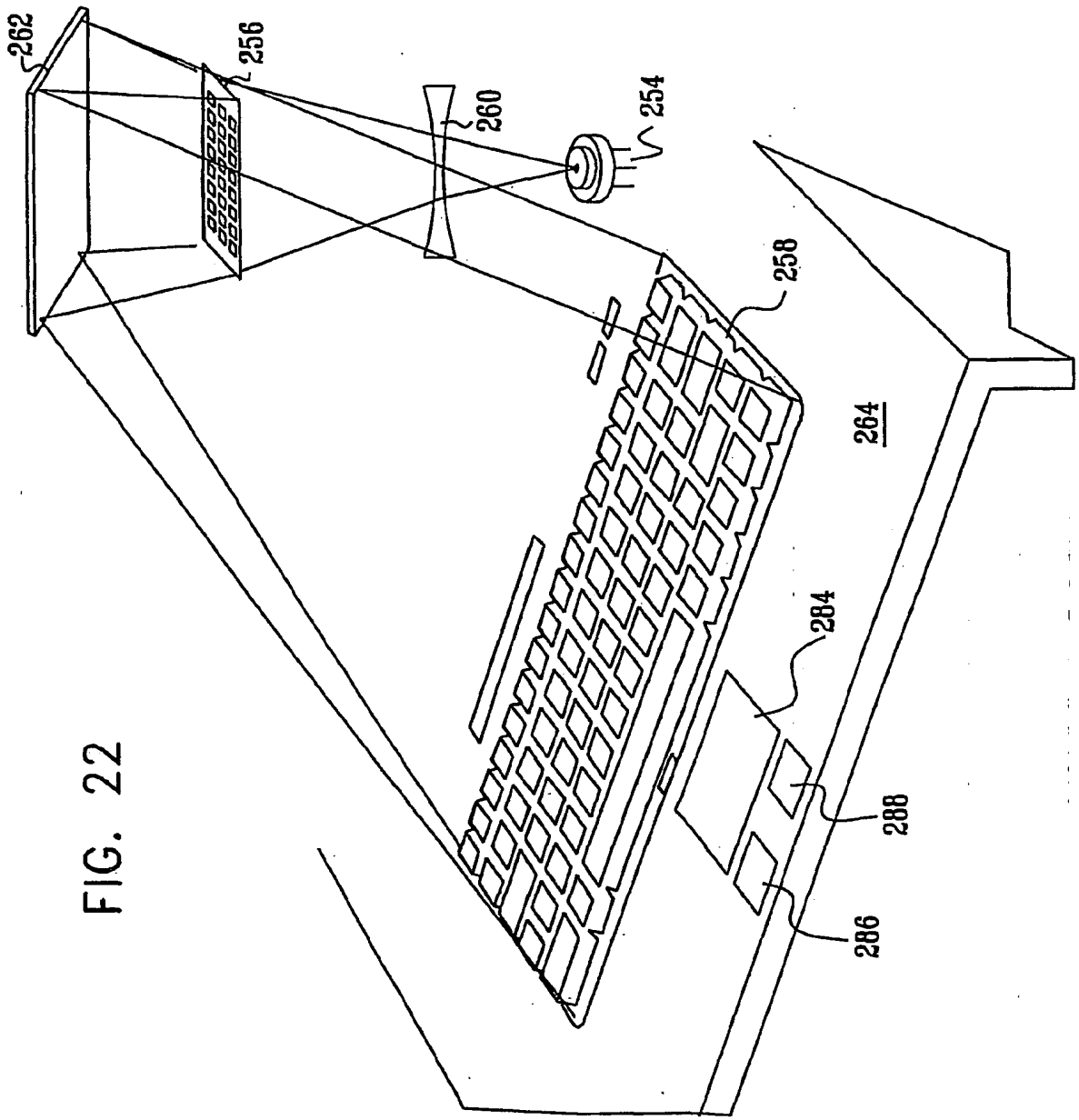


FIG. 22

FIG. 24

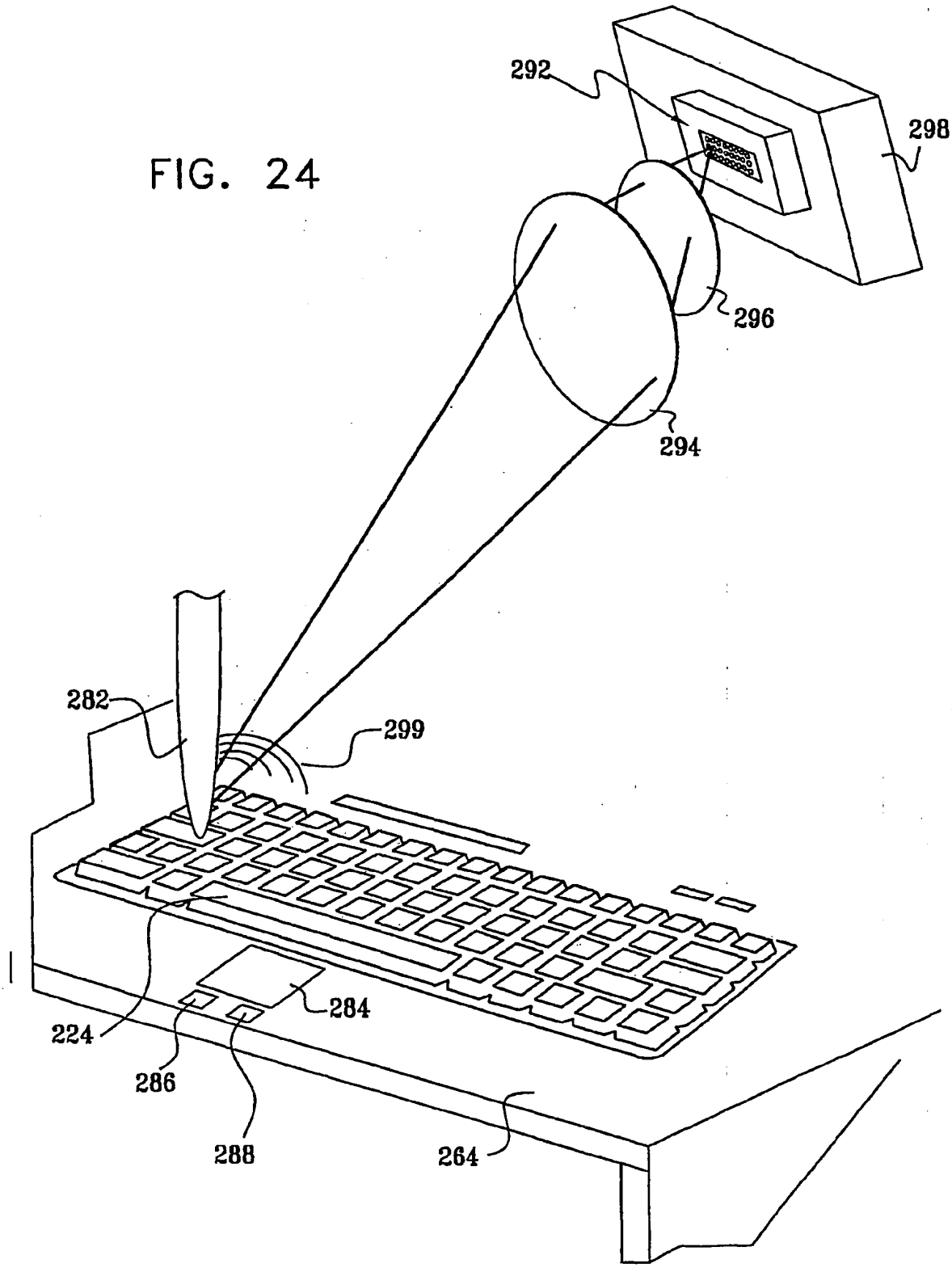


FIG. 26

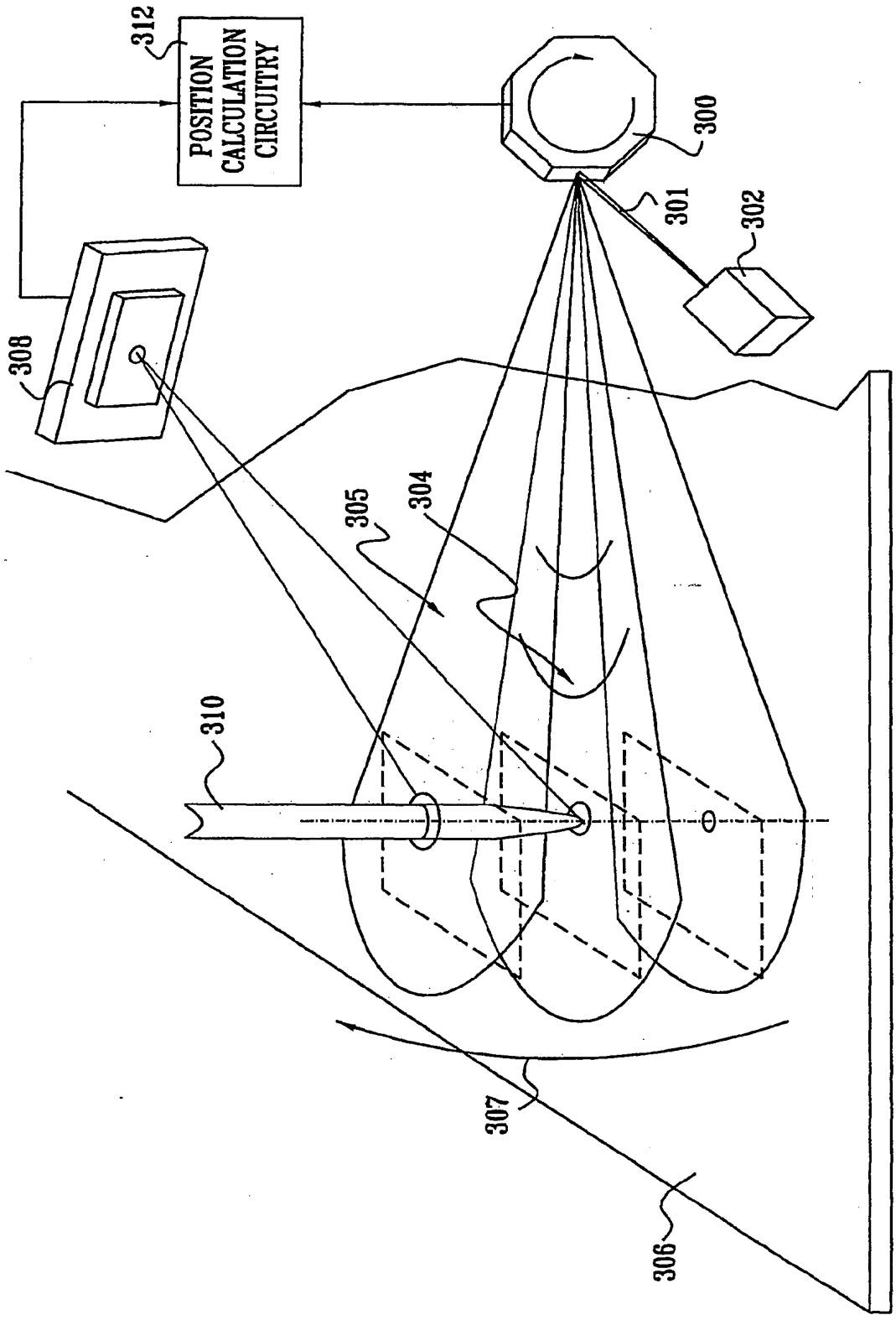

312
POSITION CALCULATION CIRCUITRY
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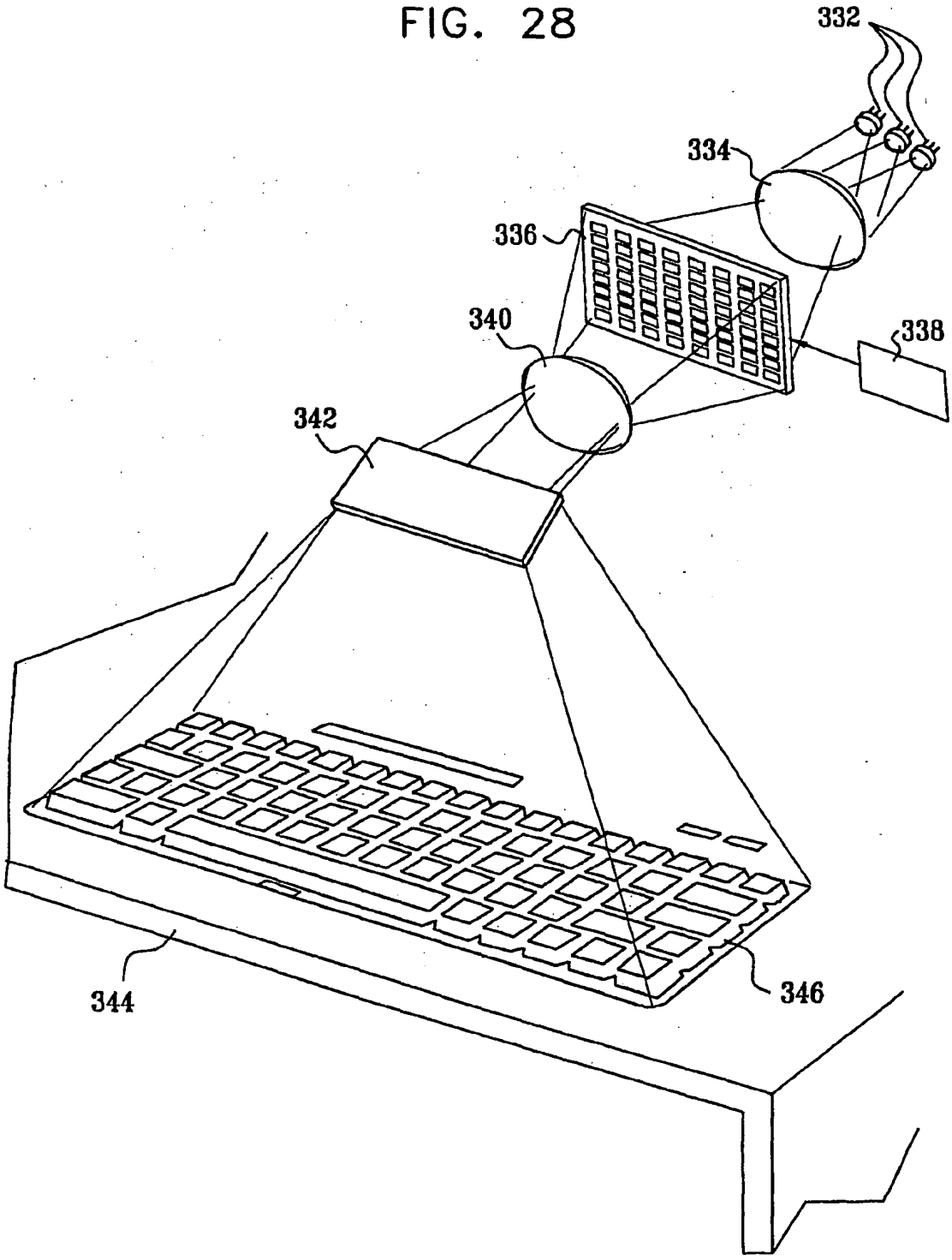
FIG. 28



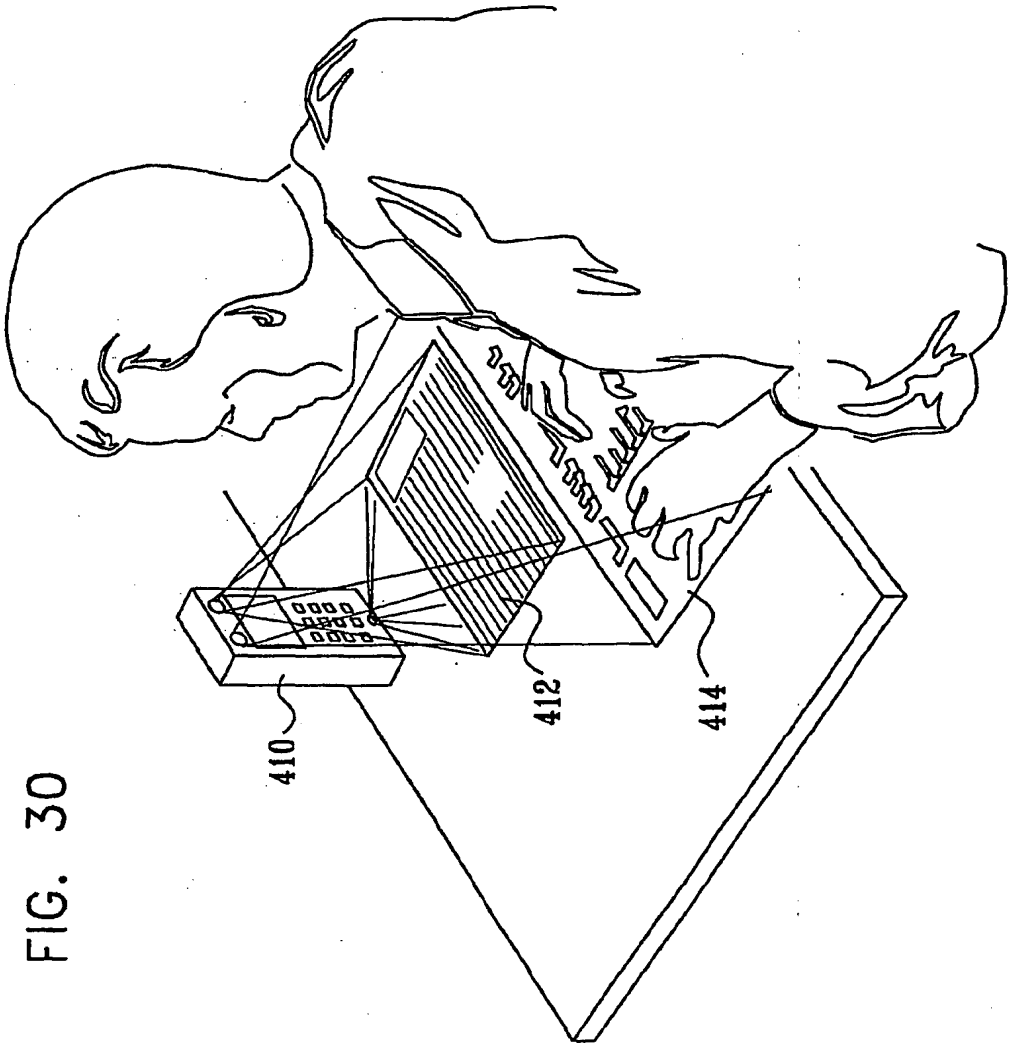


FIG. 30

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL01/00480

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : G06K 7/10
US CL : 235/472.01-03
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 235/472

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,914,481 A (DANIELSON et al) 22 June 1999 (22.06.1999), columns 4-8, lines 35-6	1-63, 97-115
Y	US 6,064,766 A (SKLAREW) 16 May 2000 (16.05.2000), columns 3-5, lines 17-8	1-115
Y, P	US 6,149,062 A (DANIELSON et al) 21 November 2000 (21.11.2000), columns 3-7, lines 56-26	1-115

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 September 2001 (24.09.2001)	15 NOV 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer John E Breene Peggy Harrod Telephone No. 703-305-3800

Form PCT/ISA/210 (second sheet) (July 1998)